FOMi-E1/T1

High Speed Fiber Optic Modem
Installation and Operation Manual

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For further information contact RAD Data Communications at the address below or contact your local distributor.

RAD Data Communications
Headquarters
12 Hanechoshet Street
Tel Aviv 69710 Israel
Tel: 972-3-6458181
Fax: 972-3-6498250
E-mail: rad@rad.co.il

RAD Data Communications
US East
900 Corporate Drive
Mahwah, NJ 07430 USA
Tel: (201) 529-1100
Fax: (201) 529-5777
E-mail: market@radusa.com

RAD Data Communications
US West
3631 South Harbor Boulevard
Suite 250
Santa Ana, CA 92704
Tel: (714) 850-0555
Fax: (714) 850-1555

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The safety status of each of the ports on the FOMi-E1/T1 is declared according to EN 41003 and is detailed in the table below:

Ports	**Safety Status**
E1, T1 (electrical)	SELV Circuit operating with Safety Extra-Low Voltage

Regulatory Information

FCC-15 User Information

This equipment has been tested and found to comply with the limits of the Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to the radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

Declaration of Conformity

Manufacturer's Name: RAD Data Communications Ltd.

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Tel Aviv 69710
Israel

declares that the product:

Product Name: **FOMi-E1/T1**

Conforms to the following standard(s) or other normative document(s):

EMC:	EN 55022 (1994)	Limits and methods of measurement of radio disturbance characteristics of information technology equipment.
	EN 50082-1 (1992)	Electromagnetic compatibility - Generic immunity standards for residential, commercial and light industry.
Safety:	EN 60950 (1992/93)	Safety of information technology equipment, including electrical business equipment.

Supplementary Information:

The product herewith complies with the requirements of the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC. The product was tested in a typical configuration.

Tel Aviv, November 18th, 1998

Haim Karshen
VP Quality

European Contact: RAD Data Communications GmbH, Lyoner Strasse 14, 60528 Frankfurt am Main, Germany

Quick-Start Guide

If you are familiar with fiber optic modems, use this guide to prepare FOMi-E1/T1 for operation.

QS.1 Installing FOMi-E1/T1

For most normal installations, setup of FOMi-E1/T1 should be performed in the following order (see *Chapters 2 and 3* for details of each procedure):

Warning

Make sure that the AC power cord is disconnected before removing the unit's cover.

Jumper Setting

1. Remove the internal board.
2. Set Cable Type jumper as required (75Ω unbalanced for E1, 120Ω balanced for E1 or 100Ω balanced for T1) (*see section 2.4 for details).*
3. Replace the board and close the unit.

Setup

1. Install the unit in a rack (optional, *see Appendix A* for details).
2. Disconnect the cables from the units.

Configuration via Front Panel

1. Configure modem with remote modem details (*see Chapter 3).*
2. Connect the units to the DTEs.
3. Configure the DTE parameters.
4. Configure the Line parameters.

Alarms Check

Make sure that there are no alarms indicated on the LCD.

QS.2 Operating FOMi-E1/T1

Connections

1. Connect the fiber optic cables.
2. Connect the power cable.
   FOMi-E1/T1 is turned on automatically upon connection to a power source.
3. If there is an indication of a malfunction or fault, run the appropriate tests (see *Chapter 4*).

Preface

Foreword

This manual provides information on the technical characteristics, installation and operating instructions of FOMi-E1/T1. The manual contains the following information:

Chapter 1. Introduction

Describes the FOMi-E1/T1, the versions available, features and options. Briefly describes the Front Panel, LEDs, jumpers, connectors and fuses. This chapter also provides a basic functional description of the FCD-T1 and a short description of some of the main operations and options.

Chapter 2. Installation

Explains how to install the FOMi-E1/T1. Explains how to perform all the connections needed to setup the FOMi-E1/T1. Explains how to set the jumpers and switches.

Chapter 3. Operation

Describes the controls, indicators and functions of the FOMi-E1/T1. Explains how to operate the FOMi-E1/T1.

Chapter 4. Troubleshooting

Describes the diagnostic tests provided by the FOMi-E1/T1. Explains how to operate the Internal BER Tester and Pattern Generator. Explains the various alarms and real time messages that may be encountered. Outlines trobleshooting procedures.

Chapter 5. Sample Application

This chapter illustrates the configuration and setup of a typical application of the FOMi-E1/T1.

Conventions

Note	*A note draws attention to a general rule for a procedure, or to exceptions to a rule.*
Caution	A caution warns of possible damage to the equipment if a procedure is not followed correctly.
Warning	**A warning alerts to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the equipment. If these instructions are not followed exactly, possible bodily injury may occur.**

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Chapter 1
Introduction

This chapter:

- Describes FOMi-E1/T1, the versions available, features and options.
- Briefly describes the Front Panel.
- Provides a basic functional description of FOMi-E1/T1 and a short description of some of the main operations and options.
- Details FOMi-E1/T1 technical specifications.

1.1 Overview

General Description

FOMi-E1/T1 is a fiber-optic modem for transmission of E1 (2048 Mbps) and T1 (1544 Mbps) signals over multimode or single-mode fiber-optic media. The unit is transparent to framing, and can transmit data using any framing pattern with HDB3 E1 or B8ZS T1 coded signals.

FOMi-E1/T1 supports both E1 and T1 in a single unit. The E1 interface fully complies with the applicable ITU standards and uses HDB3 line coding. The T1 interface fully complies with requirements of ITU G.703 and G.824 standards and uses B8ZS line coding.

Application

In the application illustrated in *Figure 1-1*, each FOMi-E1/T1 receives E1 or T1 signals, which are equalized in order to overcome electrical link distortion. FOMi-E1/T1 then converts the E1 or T1 signals into an optical signal.

The optical signal is linked to the fiber-optic media, and transmitted via the optical link to the remote unit. A high sensitivity pre-amplifier and an AGC (Automatic Gain Control) circuit enable the remote unit to receive the optical signal. The output of the receiver is applied to the clock recovery and the data re-generation circuit, which in turn applies it to the electrical interface driving circuit.

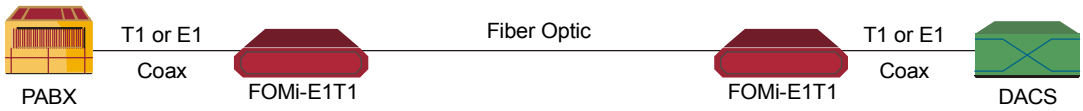

Figure 1-1 Application Diagram

Features

FOMi-E1/T1 extends the range of E1/T1 signals over fiber optic links. It is available as a standalone unit or as a card version for the LRS-12 19" modem rack with SNMP management.

FOMi-E1/T1 supports E1 balanced and unbalanced (coax) interfaces and is transparent to framing. Operating over multimode or single mode fibers, FOMi-E1/T1 has a transmission range up to 100 km using the laser diode option.

FOMi-E1/T1 conforms to all relevant ITU standards; diagnostic loops conform to ITU V.54 standard.

Full management of local and remote units is available from the front panel. Alarms are indicated in real time, for local and remote units, including dry contact external alarms, on the front panel LCD or on the attachable PCU. FOMi-E1/T1 features a built-in V.52 BER tester.

FOMi-E1/T1 is designed to operate with several different grades and sizes of fiber-optic cable, and provides the user with:

- Extended range for high-rate transmission
- Immunity to electrical interference such as EMI, RFI, spikes and differential ground loops
- Secure data transfer (no tapping on the information passed)
- Protection from sparking and lightning
- A secure link in hazardous or hostile environments.

Versions

The FOMi-E1/T1 unit is supplied in a compact, standalone case that can either be placed on a desk top/shelf, or mounted in a 19" rack (with adapters). A card version for the LRS-12 manageable rack, which can accommodate up to 12 modem cards, is also available.

The modem can be ordered as either master version or slave version. The FOMi-E1/T1 slave version features a proprietary 20-pin connector for connection to the PCU unit.

The following ordering options are available:

- 850 nm multimode
- 1300 nm LED for singlemode or multimode fibers
- LASER diode for increased range over 1300 nm or 1550 nm singlemode fibers.

1.2 Physical Description

FOMi-E1/T1 is a compact unit, intended for installation on desktops or shelves. The unit height is 4.4 cm (1.7") (see *Figure 1-2*).

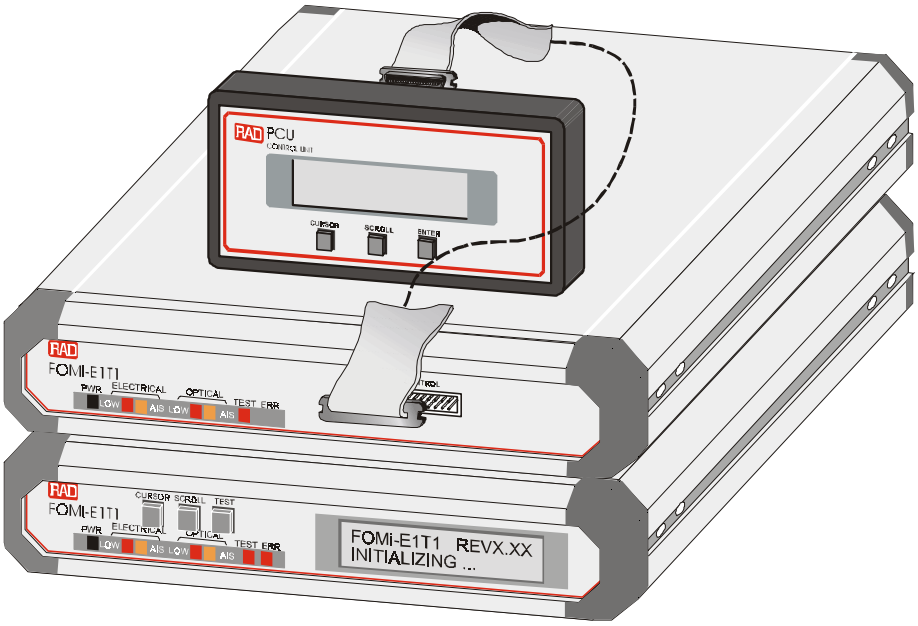

Figure 1-2 FOMi-E1/T1 Simplified Block Diagram

Front Panel

All controls (buttons and LCD) and LED indicators are located on the FOMi-E1/T1 front panel. On the master unit of FOMi-E1/T1 and on the PCU there are three buttons on the front panel – "**SCROLL,**" "**CURSOR,**" and "**ENTER.**" These buttons allow you to work through the menu displayed on the front panel LCD, change the system configuration, or monitor the system status. The front panel of the FOMi-E1/T1 master version and the PCU features an LCD of 2 rows, 16 characters each, which displays the user menu. The slave version features a proprietary 20-pin connector for connection to the PCU unit.

See Chapter 3 for details on the function of each button and indicator on the master and slave versions.

Rear Panel

The rear panel connectors and their uses are described in *Chapter 2*, Installation. The internal jumpers and preset switches are also described in *Chapter 2*.

1.3 Functional Description

General

This section describes the functional circuitry of FOMi-E1/T1 and focuses on the requirements for setting the correct configuration of the modem. See *Figure 1-3* for a block diagram of FOMi-E1/T1 circuitry.

Main Principles of Operation

FOMi-E1/T1 is a high speed data link between computers, routers or multiplexers.

FOMi-E1/T1 utilizes a Phase Locked Loop (PLL) circuit to recover jitter-free data and clock from the optical signal. FOMi-E1/T1 converts electrical signals from the DTE unit into an optical signal using an infrared light emitting diode at 850 nm, 1300 nm, or a laser diode at 1300 nm or 1550 nm. At the opposite end of the fiber, the optical signal is converted back into an electrical signal in compliance with the appropriate interface.

Electrical Interfaces

To recover data and clock from the signal, a Phase Locked Loop (PLL) circuit is utilized. FOMi-E1/T1 provides internal selection for the following electrical interfaces: (E1) 75Ω unbalanced and 120Ω balanced; (T1) 100Ω balanced.

When FOMi-E1/T1 detects that the electrical interface levels are below G.703 electrical levels, or if the Bit Error Rate (BER) on the optical interface is higher than 1×10^{-5}, the modem transmits an all "1" signal (AIS) to the optical interface.

When an all "1" signal (AIS) is detected at the optical or electrical interface, the modem transparently converts the signal and alerts the user via front panel LEDs and the supervisory port.

Power Supply

The power supply converts from -48 VDC, +24 VDC, 100 VAC, 115/230 VAC input voltage to ±5V output voltage.

G.703 Interface

The modem has the capability of accepting the following digital interfaces: G.703-E1 (2048 Kbps), or G.703-T1 (1544 Kbps).

Fiber Optic Interfaces

The modem can accept the following fiber optic interfaces:

- Infrared LED at 850 nm
- Infrared LED at 1300 nm
- Laser diode at 1300 nm
- Laser diode at 1550 nm in the SC, ST, FC optical connectors.

BERT

The pattern generator sends a standard 511-bit pseudo-random pattern to the remote unit when the user activates the modem diagnostic. At the same time, the pattern receiver checks the data received from the remote unit and compares it with the standard 511-bit pattern.
If errors are detected, the ERR LED indicator flashes or remains ON. The errors are also displayed on the LCD.

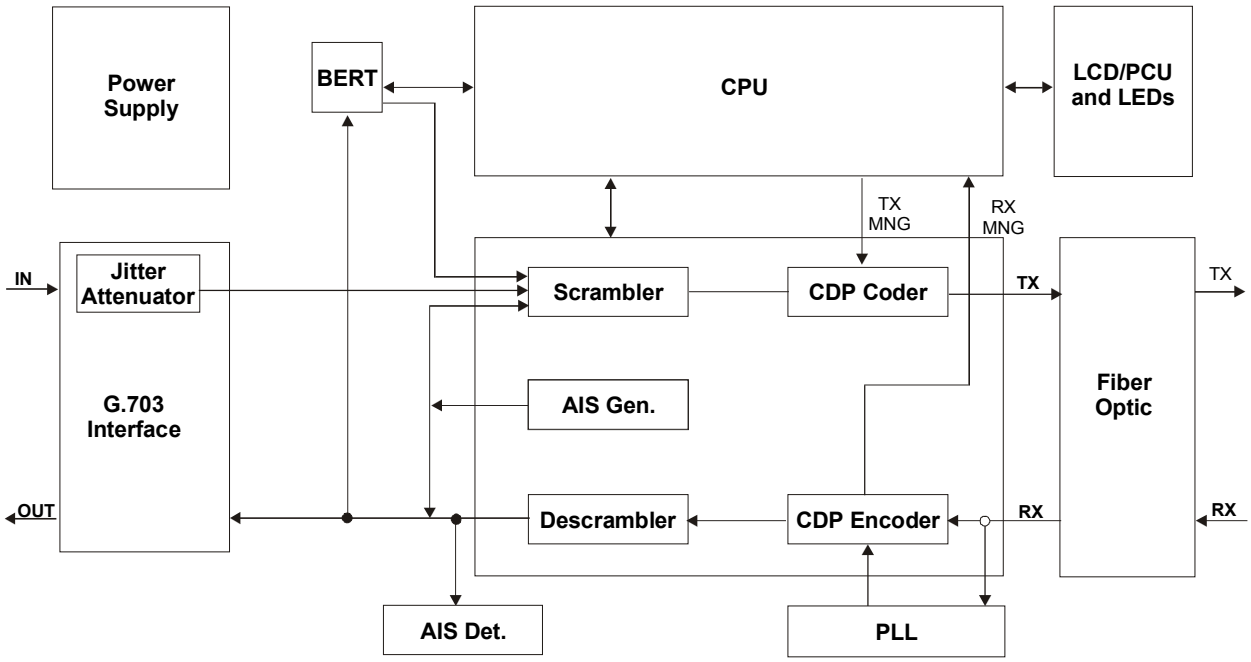

Figure 1-3 FOMi-E1/T1 Simplified Block Diagram

1.4 Technical Specifications

Electrical Interface

The electrical interface meets requirements of ITU G.703, G.921 and G.956 standards for E1 and T1.

Transmission rates	2.048 Mbps for E1 standards 1.544 Mbps for T1 standards
Interface	User selectable by means of internal switches: – 75Ω unbalanced E1 – 120Ω balanced for E1 – 100Ω balanced for T1
Zero suppression	E1: HDB3 T1: B8ZS
Connectors	RJ-45 (RJ-48C) for T1 or E1 balanced interfaces Two BNC connectors for E1 unbalanced interface.

Power

115V or 230 VAC	50/60 Hz, 20W max.
-48 VDC	-36 to -72 VDC 20W max.

Optical Interface

Operating Wavelength	– 850 nm (multimode) – 1300 nm (single-mode) – 1550 nm (single-mode)
Connectors	ST or FC-PC or SC

Range

Table 1-1 Power Coupled into Fiber and Approximate Application Range

Fiber Type	850 nm		1300 nm		1300 nm laser		1550 nm laser	
	dBm	km	dBm	km	dBm	km	dBm	km
9/125	-	-	-18	45	-12	60	-12	100
62.5/125	-18	5	-	-	-	-	-	-

Receiver sensitivity	For BER: 10^{-9} 38 dBm at 850 nm 40 dBm at 1300 nm 40 dBm for laser 1300 nm 40 dBm for laser 1550 nm

	Dynamic range	28 dB for all types of optical interfaces
	Budget (Max)	20 dB for 850 nm over 62.5/125 22 dB for 1300 nm over 9/125 28 dB for 1300 nm laser over 9/125
General Indicators	*POWER (green)*	On when the unit is powered.
	ELECTRICAL LOW (red)	On when the electrical interface input is below G.703 electrical levels.
	ELECTRICAL AIS (yellow)	On when an all "1" string is received at the electrical interface.
	OPTICAL ERR (red)	On when Bit Error Rate of the received signal from the optical interface is 10^{-6} or worse.
	OPTICAL AIS (yellow)	On when an all "1" string is received at the optical interface.
	TEST (red)	On when a test is active at the local or the remote unit.
	ERR (red)	On when an alarm condition is initiated, or blinking when an error is detected in the data stream.
Diagnostics	*Local (LLB)*	Analog loopback, activated from the front panel, from a PCU, or from the remote unit.
	Remote (RLB)	Digital loopback, through the remote modem and remote DTE, activated from the front panel, from the PCU, or from the remote unit.
	Remote + BERT	A remote digital loopback with internal BER tester.
	BERT	Built-in pattern generator and tests, activated from the front panel, from the PCU, or from the remote unit. Performs BER test over the link.
	LED Check	LEDs test, activated from the front panel or the PCU.

Controls and Displays	*LCD*	Two rows of 16 characters (Master Unit)
	Buttons	CURSOR, SCROLL, ENTER (Master and PCU units)
	Indicators	See *Section 3.1*
Physical Dimensions		Height 4.4 cm / 1.7 in (1U) Width 24 cm / 9.6 in Depth 19.3 cm / 7.6 in Weight 1.4 kg / 3.1 lb
Environment	*Operating Temperature* *Humidity*	0-50°C /32-122°F Up to 90%, non-condensing

Chapter 2

Installation & Setup

This chapter provides mechanical and electrical installation procedures for FOMi-E1/T1. If a problem is encountered, refer to Chapter 4 for troubleshooting instructions.

FOMi-E1/T1 is supplied as a fully assembled standalone unit. FOMi-E1/T1 can be adapted to fit into a 19" rack (to order the rack mount adapter kit, see *Ordering Options on the FOMi-E1/T1 data sheet*). See *Appendix A* for rack mount adapter installation instructions.

2.1 Site Requirements and Prerequisites

Power

AC-powered FOMi-E1/T1 units should be installed within 1.5m (5 ft) of an easily accessible, grounded AC outlet capable of furnishing the required supply voltage of the unit (115 or 230 VAC).

DC-powered FOMi-E1/T1 units require a -48 VDC power source which must be adequately isolated from the mains supply.

In order to prevent a fire hazard, the (negative) supply line must contain a suitable fuse or a circuit breaker.

Ambient Requirements

The ambient operating temperature of FOMi-E1/T1 is 0–50°C (32–122°F) at a relative humidity of up to 90%, non-condensing.

Allow at least 90 cm (36 in) of frontal clearance for operating and maintenance accessibility. Allow at least 10 cm (4 in) clearance at the rear of the unit for signal lines and interface cables.

2.2 Package Contents

The package of the FOMi-E1/T1 standalone unit includes:

- FOMi-E1/T1 modem (protected by adequate cushioning)
- AC power cord or DC power supply connector kit
- FOMi-E1/T1 ***Installation and Operation Manual***

2.3 Equipment Needed

To operate the standalone version of the FOMi-E1/T1 modem on a desktop or shelf, no additional equipment is needed.

To install the standalone version of the FOMi-E1/T1 modem in a 19" rack (either single or in a side by side configuration when a couple is needed), a rack adapter kit, RM-9, is required (for rack installation instructions refer to *Appendix A*).

2.4 Jumper Setting

Warning

Access to the inside of the equipment is permitted only to authorized and qualified service personnel.

To avoid accidental electric shock, always disconnect the interface cables and the power cord before removing the unit from its casing.

Line voltages are present inside FOMi-E1/T1 when it is connected to power and/or to the lines. Moreover, under external fault conditions dangerous voltages may appear on the lines connected to the unit.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled technician who is aware of the hazard involved. Capacitors inside the instrument may remain charged even after the instrument has been disconnected from its power supply source.

➤ **To open the FOMi-E1/T1 case:**

1. Disconnect the power cord from the mains outlet.
2. Release the two rear panel screws and use them as levers to slide the PCB interior out of the unit.

➤ **To set the jumpers:**

1. Identify the jumper according to the configuration diagram (see *Figure 2-2*).
2. Set the cable type jumper as required:
   E1 unbalanced (75Ω)
   E1 balanced (120Ω)
   T1 balanced (100Ω)
   (230 VAC and -48 VDC options are factory preset to E1 (120); 115 VAC is factory preset to T1.)

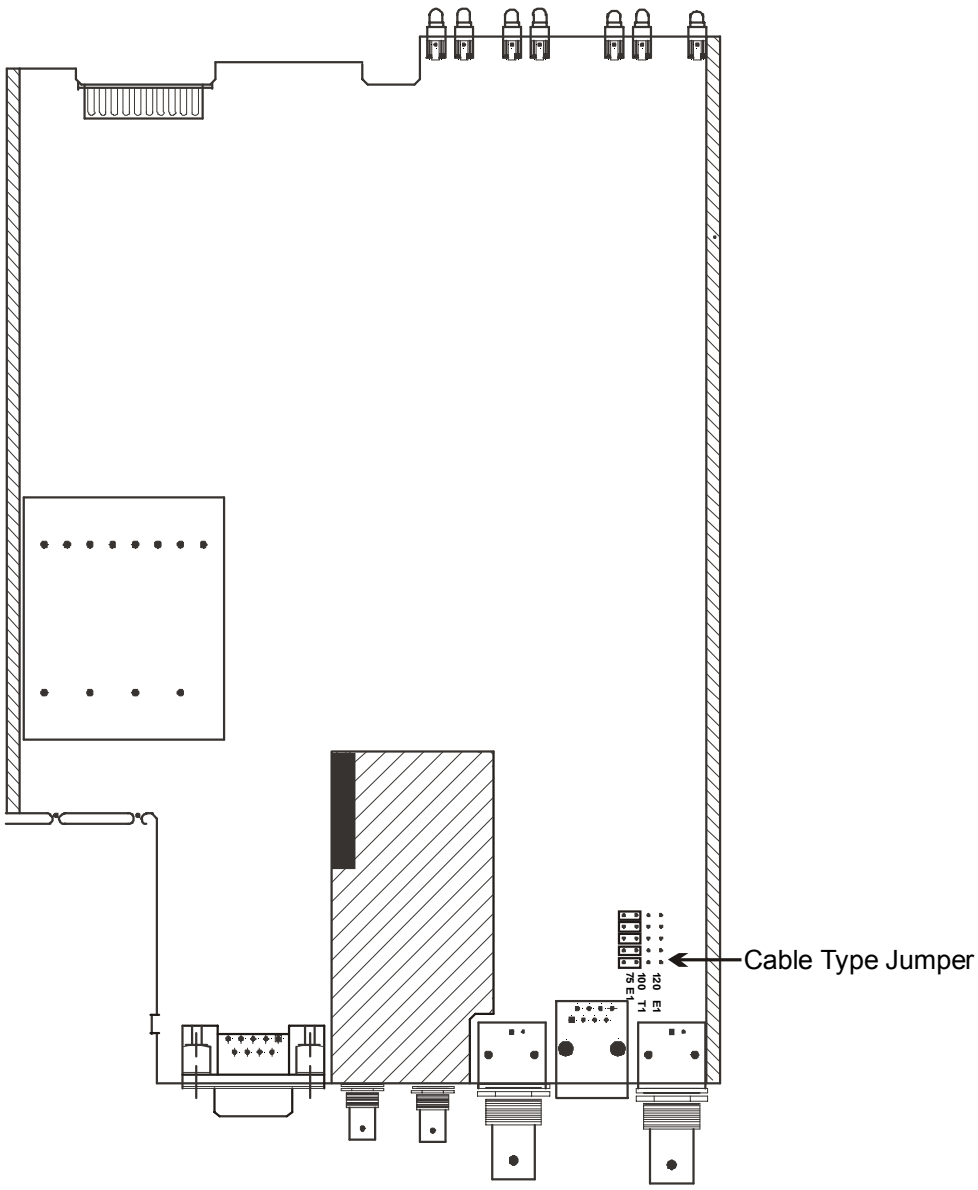

Figure 2-1 FOMi-E1/T1 Stand Alone PCB Layout

➤ **To return FOMi-E1/T1 to its case:**

1. Insert the board firmly into the FOMi-E1/T1 case.
2. Insert the FOMi-E1/T1 top cover by pushing it straight down.
3. Insert and tighten the four cover screws.

Connecting the Interfaces

Figures 2-3 and 2-4 show the rear panel of a standard version FOMi-E1/T1 unit and identify connector locations for the AC and DC versions, respectively.

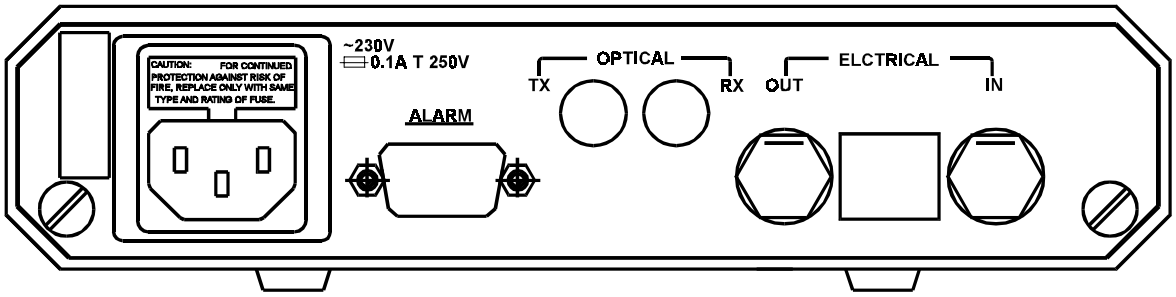

Figure 2-2 FOMi-E1/T1 Rear Panel, AC Power Connection

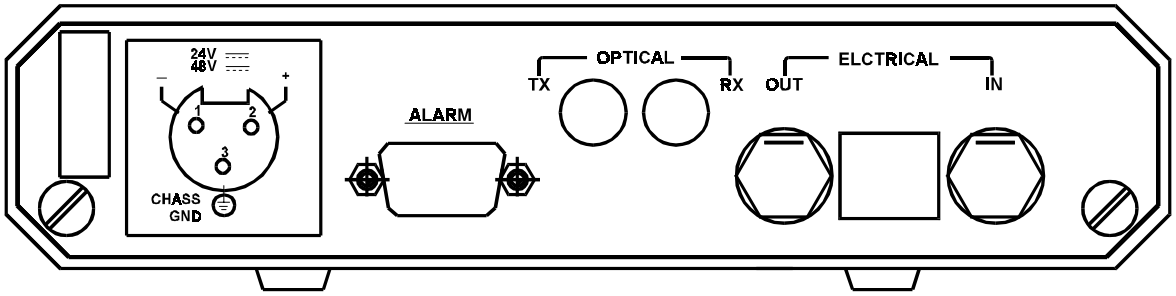

Figure 2-3 FOMi-E1/T1 Rear Panel, DC Power Connection

Connecting the Fiber-Optic Cables

Two fiber-optic SC, ST or FC-PC connectors are located on the rear panel and marked TX and RX.

➤ **To connect the fiber-optic cables:**

1. Remove the protective caps from the connectors and store them in a safe place for later use.
2. Connect the transmit fiber to the connector of the central unit marked TX and the receive fiber to the connector marked RX.
3. At the remote unit connect the transmit fiber to RX and the receive fiber to TX.

Connecting the Electrical Cable

The E1, balanced link and T1-link connections are connected via an RJ-45 connector, or two BNC connectors for E1, unbalanced link. The BNC connectors are designed as OUT and IN. OUT refers to a signal transmitted from the FOMi-E1/T1 to the attached equipment. IN refers to the FOMi-E1/T1 input signal.

The RJ-45 pin connector is used for connection of T1 (see *Tables 2-1*).

Table 2-1 RJ-45 Pin Assignment

Pin No.	Designation/ Function
1	TTIP
2	TRING
3	Frame Ground
4	RTIP
5	RRING
6	Frame Ground
7, 8	Not connected

Warning

The E1 and T1 ports should be connected to SELV (Safety Extra Low Voltage) links only.

Dry Contact Alarm

The supervisory port is a 9-pin, D-type connector which provides dry contact for major and minor alarms.
For more information and pinout, see *Chapter 4*, *Table 4-4*.

Connecting the Power

To connect the power to FOMi-E1/T1, refer to the appropriate section below, depending on your version of the unit (DC or AC).

Warning

The unit has no power switch. Operation starts when power is applied to the rear panel POWER connector. When applying power, first connect the plug of the power cord to the FOMi-E1/T1 POWER connector and then to the mains power source (outlet).

Grounding

Before switching on this instrument, connect the protective earth terminals of this instrument to the protective conductor of the (mains) power cord. Insert the mains plug only into a socket outlet with a protective earth contact. Only use an extension cord (power cord) with a protective conductor (grounding).

Replace fuses only with fuses of the same current and voltage rating as indicated on the unit. Do not short-circuit fuse holders. Whenever it is likely that the protection offered by fuses has been impaired, the instrument must be made inoperative and secured against any unintended operation.

For your protection, FOMi-E1/T1 must always be grounded. Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnection of the protective earth terminal can render this instrument dangerous. Intentional interruption is prohibited.

AC Power Connection

AC power should be supplied to FOMi-E1/T1 through the 5 ft (1.5m) standard power cable terminated by a standard 3-prong plug (see *Figure 2-2*). The cable is provided with the unit.

➤ **To connect AC power to FOMi-E1/T1:**

- Connect the power cable to the connector on the FOMi-E1/T1 rear panel and then to the mains outlet.
  The unit turns on automatically upon connection to the mains.

DC Power Connection

➤ **To connect DC power to FOMi-E1/T1**

- Refer to *DC Power Supply Connection Supplement*.

Fuse

The fuse is located in an integral-type fuse holder located on the rear panel (see *Figure 2-3*) Make sure that only fuses of the required rating, as marked on the FOMi-E1/T1 rear panel, are used for replacement. Do not use repaired fuses or short-circuit the fuse holder. Always disconnect the mains cable before removing or replacing the fuse.

If the fuse protection has been damaged, disconnect the unit from the power mains and secure it against unintended operation.

2.5 Initial Operation and Basic Checks

Power-On Procedure

FOMi-E1/T1 is turned on as soon as power is connected. When power is connected, the PWR LED lights up to indicate that the FOMi-E1/T1 is on.

When the unit is powered ON, operating personnel are not exposed to voltage in excess of 30 volts on any card or accessible area of the DC power supply.

Normal Operating Indications

Table 2-1 lists the correct status of the indicators, a few seconds after power-up.

Table 2-2 FOMi-E1/T1 Indicator Status

Indicator	Status
PWR	ON
LCD Display	Displays opening screen: "FOMi-E1/T1 REV X.X I N I T I A L I Z I N G..."
ERR	ON ("SYNC-LOSS" always occurs during power-up)
Test	OFF

Power-Off Procedure

FOMi-E1/T1 is turned off by disconnecting its power. Always disconnect the power cord from the mains outlet first.

Chapter 3

Operation

This chapter describes FOMi-E1/T1 front panel controls and indicators and their functions. It also explains how to configure and operate the modem LCD menu.

All the installation procedures described in *Chapter 2* must be completed and checked out successfully before you attempt to operate FOMi-E1/T1.

3.1 Controls and Indicators

All controls and indicators are located on the front panel of FOMi-E1/T1. On the master unit of FOMi-E1/T1 and on the PCU unit, there are three front panel button switches: **SCROLL, CURSOR,** and **ENTER** (see *Figures 3-1 and 3-3*). Using these switches, the user can toggle through the menu displayed on the front panel LCD, change the system configuration, or monitor the system status. Both the front panel of the FOMi-E1/T1 master version and the PCU have an LCD with 2 rows, 16 characters each, for displaying the user's menu choices.

Table 3-1 lists the functions of each switch and indicator on FOMi-E1/T1 master and slave versions and on the PCU. The Item numbers in the table correspond to the call-outs in *Figures 3-1, 3-2 and 3-3*.

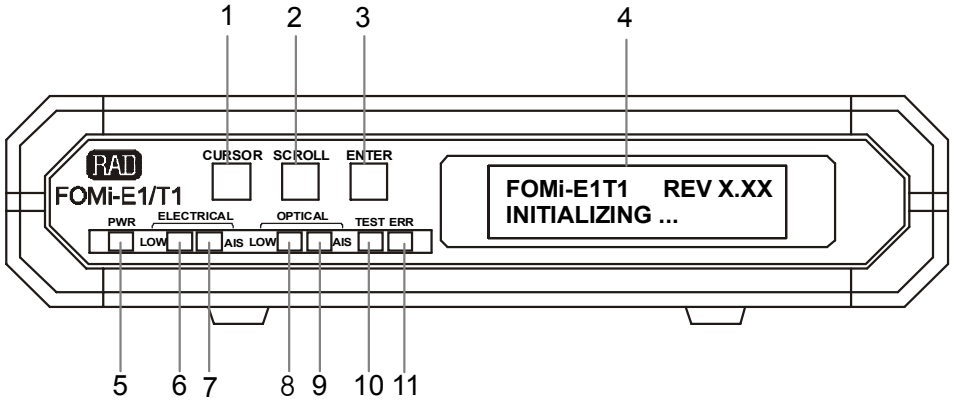

Figure 3-1 FOMi-E1/T1 Master Front Panel

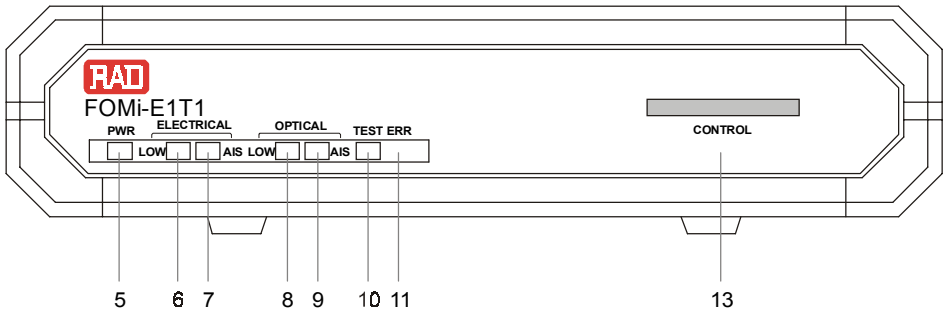

Figure 3-2 FOMi-E1/T1 Slave Front Panel

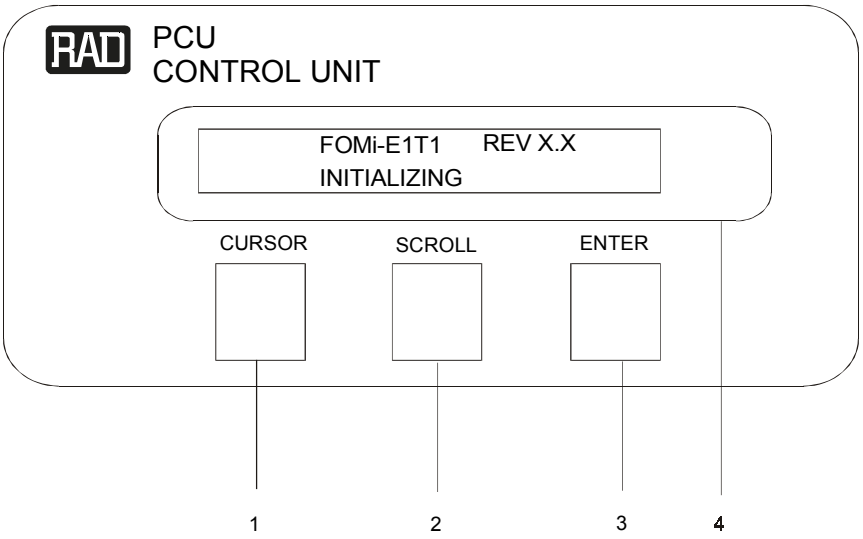

Figure 3-3 PCU Front Panel

Table 3-1 FOMi-E1/T1 Controls and Indicators

Item	Name	Type	Function
1	CURSOR	Button	Moves the cursor between the LCD fields.
2	SCROLL	Button	Moves between options of the current menu.
3	ENTER	Button	Selects the current option and updates both local and remote modem data bases.
4	LCD display	LCD display	Displays the current menu screen and cursor position.
5	PWR (green)	LED indicator	On when power is on.
6	ELECTRICAL LOW (red)	LED indicator	On when electrical interface input is below G.703 electrical levels.
7	ELECTRICAL AIS (yellow)	LED indicator	On when an "all 1s string" is received at the electrical interface.
8	OPTICAL LOW (red)	LED indicator	On when Bit Error Rate of the received signal from the optical interface is 10^{-6} or worse.
9	OPTICAL AIS (yellow)	LED indicator	On when an "all 1s string" is received at the optical interface.
10	TEST (red)	LED indicator	On when the unit is in any of the two loopback modes and/or when PATT is activated.
11	ERR (red)	LED indicator	On when an alarm is initiated Blinks whenever an error is detected in BER tests.
13	CONTROL	Connector	20-pin connector for controlling via the PCU.

3.2 Operating Procedures

The FOMi-E1/T1 front panel LCD and buttons enable the user to control and monitor both local and remote modems using menu-driven software. This section describes the various menus and how to use them to operate FOMi-E1/T1.

Menu operations are selected by the three front-panel buttons and displayed on the LCD display.

The LCD display is comprised of four data fields, as shown in *Figure 3-4*, below.

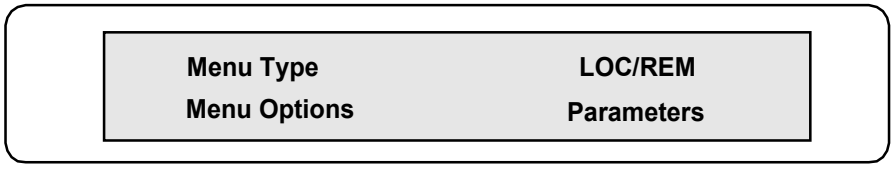

Figure 3-4 LCD Data Fields

The function of the data fields is as follows:

Menu Type	Displays the available control menus
LOC/REM	Toggles between controlling and monitoring the local modem or the remote modem
Menu Options	Contains the control and monitoring options of each control menu
Parameters	Displays the current parameter for the controllable menu options

Menu operations are selected by the three front-panel buttons and displayed on the LCD display. The buttons operate as follows:

CURSOR	Selects the field.
SCROLL	Enters through the field options.
ENTER	Confirms and accepts a selected option.

General Instructions

➤ **To select a parameter, proceed as follows:**

1. Press **CURSOR** until the cursor is on the **Menu Type** field.
2. Press **SCROLL** until the required menu appears in the **Menu Type** field.
3. Press **CURSOR** until the cursor is on the **Menu Options** field.
4. Press **SCROLL** until the required menu option appears.
5. Press **CURSOR** to move the cursor to the **Parameters** field.
6. Press **SCROLL** until the required parameter appears.
7. Press **ENTER**.

An asterisk (*) appears at the left of the selected parameter.

Figure 3-5 details the schematics of the FOMi-E1/T1 menu options.

The menu concept is circular: the menu options are displayed on the LCD one after the other in a cyclic order.

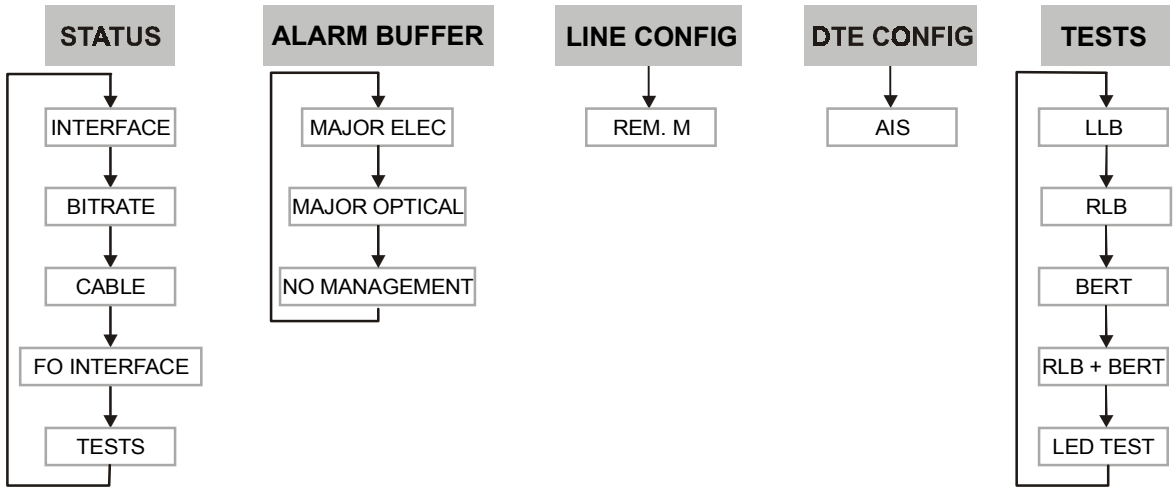

Figure 3-5 FOMi-E1/T1 Menu Option Menu

Note *If a menu option is left unchanged for more than one minute, the unit automatically returns to the* STATUS *menu; if there is an alarm stored in the* ALARM BUFFER*, the unit displays the* ALARM BUFFER *menu*.

The six main menus are briefly described in the table below.

Table 3-2 Menu Type Options

Menu Type	Description
STATUS	The STATUS menu enables the user to monitor the current status of the modem.
ALARM BUFFER	FOMi-E1/T1 contains a buffer which stores the system alarms. When alarms are stored in the alarm buffer, the **ERR** LED indicator is set to **ON**. Once the alarm buffer is cleared, the **ERR** LED turns off. For ALARM BUFFER details see *Chapter 4, Troubleshooting and Diagnostics*.
LINE CONFIG	The LINE CONFIG menu supports the configuration of the line parameter and allows you to select the mode of operation to fit to the remote modem type.
DTE CONFIG	The DTE CONFIG menu supports configuration of AIS for both local and remote DTEs.
TESTS	The TESTS menu provides the capability for executing several diagnostic tests on the local and remote modems. For more information, refer to *Chapter 4*.

Viewing Modem Configuration (STATUS)

The STATUS menu enables the user to monitor the current status of the modem. Monitoring of either local or remote modem is enabled by toggling between LOC (local) and REM (remote) modems. The status of a remote modem can be monitored only if the management is active. Refer to
Table 3-2 for a complete list of possible modem STATUS options and

parameters.

Table 3-3 STATUS *Menu Options*

Menu Options	Indicates	Parameter Values	Description
Interface	Current electrical interface	G.703	G.703-E1 (2048 Kbps), or G.703-T1 (1544 Kbps)
Bit Rate	Line Bit Rate	2048 kbps 1544 kbps	
Cable	Electrical interface rate	75 120 100	**E1** 75Ω unbalanced, 120Ω balanced; **T1** 100Ω balanced
FO Interface		SC85 ST85 FC85 SC13 ST13 FC13 SC13L ST13L FC13L SC15L FC15L ST15L	SC, ST, FC optical connectors: Infrared LED at 850 nm Infrared LED at 1300 nm Laser diode at 1300 nm Laser diode at 1550 nm
REM. M	This option is displayed only if management is active.	FOM-E1/T1 NEW	Displays the far end modem type.
Tests	Current diagnostic status	NONE LLB RLB RLB + BERT BERT LED Test	See *Chapter 4* for more information on FOMi-E1/T1 diagnostic tests.

➤ **To view modem configuration**

1. Press the **ENTER** button to move to the **Menu Type** field.
2. Press the **ENTER** button until STATUS is displayed.
3. Press the **ENTER** button to move to the LOC/REM field.
4. Press the **ENTER** button to toggle between local modem and remote modem (if management is not active, the remote modem will not be displayed).
5. Press the **ENTER** button to move to the **Menu Options** field.
6. Press the **ENTER** button to scroll through the menu options to view the desired options; see *Figure 3-6* and *Table 3-3* for STATUS options.

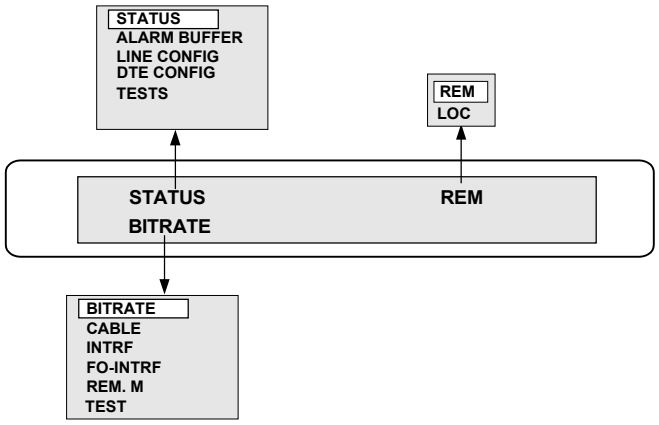

Figure 3-6 STATUS *Menu Options*

Viewing Active Alarms (ALARM BUFFER)

FOMi-E1/T1 contains a buffer which stores the system alarms. When alarms are stored in the alarm buffer, the **ERR** LED indicator is set to **ON**. Once the alarm buffer is cleared, the **ERR** LED turns off. For ALARM BUFFER details see *Chapter 4, Troubleshooting and Diagnostics*.

Configuring the Line (LINE CONFIG)

The LINE CONFIG menu supports the configuration of the line parameters. Refer to the following table for a complete list of configurable line parameters.

Table 3-4 LINE CONFIG *Menu Options*

Menu Options	Indicates	Parameter Values	Description
REM. M	Remote modem connection	FOM-E1/T1 NEW	Displays remote modem type
LOC. M		FOM-E1/T1 NEW	Displays local modem type

When you configure a parameter, if both modems are connected and the management is active, the message **WAIT...** will be displayed, while the local modem sends the new settings to the remote modem and receives acknowledgment. Once the acknowledgment is received, the message disappears and the new setting is displayed, with an asterisk next to it. If only the local modem is connected, or the management is not active, you can configure only the local modem. In such a case, the message **LOC CONFIG ONLY** will be displayed on the LCD, for a short period, for each parameter you set.

If, at the time you try to configure the system, the party on the other side of the line is already modifying the configuration, the message **U R BEING CONFIG** will appear on the LCD and you will not be able to modify the system.

You will only be able to modify the configuration once the other party has finished its modifications and:

- a minute has passed since the other party finished and the system returns back to STATUS, or
- the other party scrolled out of LINE CONFIG.

Setting the Remote Modem (REM.M)

FOMi-E1/T1 allows you to select the mode of operation to fit to the remote modem type. The available modems are designed for FOM-E1T1 (old version), and NEW (FOMi-E1/T1). The NEW mode of operation supports the management channel, while the FOM-E1T1 mode of operation does not support the management channel. Therefore, in the FOM-E1T1 mode of operation you cannot control or monitor the remote modem.

1. Press the **CURSOR** button to move to the **Menu Type** field.
2. Press the **SCROLL** button until LINE CONFIG is displayed.
3. Press the **CURSOR** button to move to the **Parameters** field.
4. Using the **SCROLL** button select the required mode of operation.
5. Press the **ENTER** button to set your choice (see *Figure 3-7* and *Table 3-4* for LINE CONFIG menu Options).

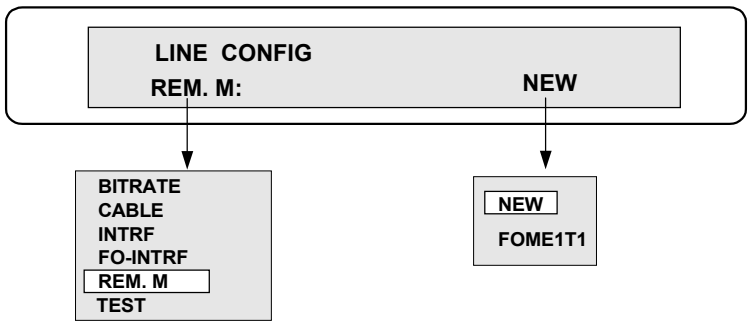

Figure 3-7 LINE CONFIG *Menu: Configuring the Remote Modem*

Configuring the DTE (DTE CONFIG)

The DTE CONFIG menu supports configuration of both local and remote DTEs (see *Table 3-5* and *Figure 3-8* for menu options).

Table 3-5 DTE Config Menu Options

Menu Options	Indicates	Parameter Values	Description
AIS	All "1" string is received at the electrical interface.	Enable Disable	When an all "1" signal (AIS) is detected at the optical or electrical interface, the modem transparently converts the signal, and alerts the user via front panel LEDs and the supervisory port.

➤ **To set the AIS**

1. Press **CURSOR** to move to the **Menu Type** field.
2. Press **SCROLL** until DTE CONFIG is displayed.
   AIS is displayed in the **Menu Options** field.
3. Press **CURSOR** to move to the LOC/REM field.
4. Press **SCROLL** to select the local modem or the remote modem.
5. Press **CURSOR** to move to the **Parameters** field.
6. Use **SCROLL** to toggle between ENABLE and DISABLE.
7. Press the **ENTER** button to set your choice.

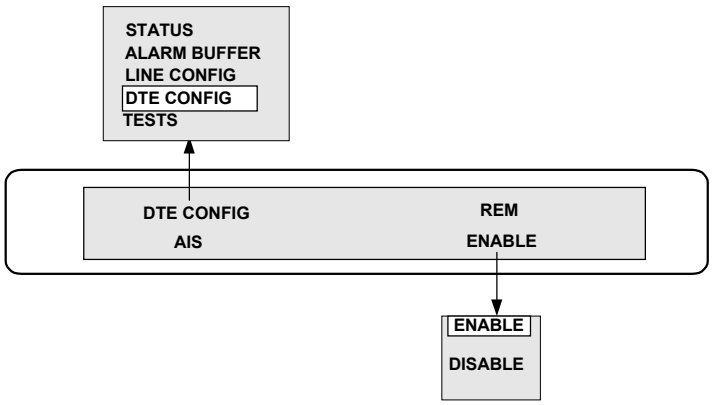

Figure 3-8 DTE Config Parameters Configuration

TESTS

The TESTS menu provides the capability for executing several diagnostic tests on the local and remote modems. For more details, refer to *Chapter 4*.

Chapter 4

Troubleshooting and Diagnostics

This chapter:

- Provides troubleshooting tips for FOMi-E1/T1.
- Describes FOMi-E1/T1 messages and alarms.
- Details FOMi-E1/T1 Diagnostic tests.

4.1 Troubleshooting

This section lists some possible failures and describes the symptoms and the corrective actions the user has to take in order to overcome these failures.

Perform the corrective actions listed in *Table 4-1* in the order given until the problem is corrected.

Table 4-1 Troubleshooting

Symptom	Possible Cause	Corrective Action
PWR LED is off.	Blown fuses	Replace the fuses. On a stand alone AC unit the fuse is on the rear panel. On a stand alone DC unit, the fuses are on the PCB, close to the power input connector.
ERR and OPTICAL LOW LEDs are on.	The line between the modems is not connected properly.	Check that the line is properly connected. Check that the wave length settings of the fiber optic interfaces on both sides match each other and match the fiber optic cable type. Check that the jumpers on both modems are set to the same baud rate.
ERR LED is on and NO MANAGEMENT alarm is stored in the alarm buffer.	The line between the modems is not connected properly.	Check that the line is properly connected. Check that the remote modem is configured to New mode of operation (LINE CONFIG menu).
ERR LED is on and NO FIBER INTERFACE alarm is stored in the ALARM BUFFER.	No FIBER optic interface, or a FIBER optic interface which is not supported by the modem.	Connect a FIBER optic interface which is supported by the modem.
ERR LED is on and SELF TEST FAILED alarm is stored in the ALARM BUFFER.	Hardware failure	Replace the unit.
ELECTRICAL LOW LED is on.	The line between the modem and the DTE is not connected.	Check that the DTE and the attached modem are set to the same baud rate. Check that the cable connecting the DTE and the modem is of the correct type and that it is not defective.

4.2 Status Indicators and Alarms

Messages

FOMi-E1/T1 responds in real time to changes in system status, dictated by the user. The messages described in *Table 4-2* override the current menu display for a period of approximately two seconds on the FOMi-E1/T1 front panel LCD or on the PCU LCD.

Table 4-2 Real Time Messages

Message	Description
"WAIT"	The system is updating the data base at this time and no other actions can be taken.
"U R BEING CONFIG"	Parameters are being configured by the party at the other side of the line (the remote modem).
"LOC CONFIG ONLY"	Parameter is modified on the local modem only; management channel is not available.
"TEST ALREADY ON"	Another test is being performed; activation of test is not valid.

Viewing Active Alarms (ALARM BUFFER)

FOMi-E1/T1 contains a buffer which stores the system alarms. When alarms are stored in the alarm buffer, the **ERR** LED indicator is on. Once the alarm buffer is cleared, the **ERR** LED turns off.

The cause of the problem is displayed in the Menu Option field. If the failure has more than one cause, scroll through the field to view the other causes.

The **ERR** LED might blink with no relation to the ALARM BUFFER when an error is detected during a BER test. The following table lists all possible FOMi-E1/T1 alarms.

Table 4-3 ALARM BUFFER *Menu Options*

Menu Options	Indicates
Major Electrical	The level of the signal at the DTE interface is low (the LOW LED, under ELECTRICAL on the front panel is lit).
Minor Electrical	A string of All "1s" is received at the electrical terminals (the AIS LED under ELECTRICAL on the front panel is on).
Major Optical	Errors are detected on the optical interface.
Minor Optical	A string of all "1s" is received at the optical terminal (the AIS LED under OPTICAL on the front panel is lit).
Self Test Failed	The unit failed the self test at power-up stage.
NVRAM failed	A hardware failure has been detected.
No Fiber Interf	There is no fiber optic interface module.
No Management	The unit cannot control the modem at the other side of the link.

➤ **To view active alarms:**

1. Press the **CURSOR** button to move to the **Menu Type** field.
2. Press the **SCROLL** button until ALARM BUFFER is displayed.
3. Press the **CURSOR** button to move to the LOC/REM field.
4. Press the **SCROLL** button, toggle between the local and the remote modem (if management is not active, the remote modem will not be displayed).
5. If an alarm message is initiated, it will be displayed in the **Menu Options** field. If there is more than one alarm, scroll through the fields, using the **SCROLL** button, to monitor all the alarms.

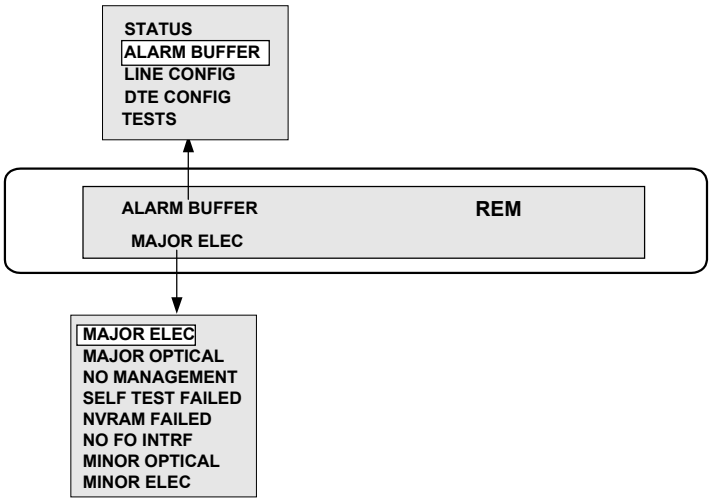

Figure 4-1 ALARM BUFFER Menu

Dry Contact Alarms

Major alarms are electrical low or optical low alarms. Minor alarms occur when a string of "1"s (AIS) is received on the electrical or optical interface. The dry contact operates as normally open or normally closed, using different pins of the 9-pin D-type connnector.

Table 4-4 Major and Minor Alarm Pin Table

Type	Contact	Pins
Minor Alarm	Normally Closed	6 and 1
	Normally Open	6 and 2
Major Alarm	Normally Closed	9 and 4
	Normally Open	9 and 5

4.3 Diagnostic Tests

FOMi-E1/T1 supports several types of loopbacks for checking the communication between the attached equipment and the local modem as well as the communication between the modems.

Use the test procedures provided in this chapter to verify normal system operation and to isolate faulty equipment and lines in the event of failure.

Do not perform tests with faulty equipment. Before performing a test, either have the equipment repaired or replace it with a functioning unit.

The following loop tests are available:

- Local Analog Loopback (LLB)
- Remote Digital Loopback (RLB)
- Remote Digital Loopback + BER (RLB + BERT).

Note *Before testing the operation of the data system equipment and its line circuits, ensure that all units are turned on and are configured correctly. Loop tests are best performed in the order presented here.*

Table 4-5 details TESTS-menu configuration options.

Table 4-5 TESTS Menu Options

Menu Options	Indicates	Parameter Values	Description
LLB	Currently Performed Test	OFF ON	Analog loopback, activated from the front panel, from a PCU, or from the remote unit.
RLB	Currently Performed Test	OFF ON	Digital loopback, through the remote modem and remote DTE, activated from the front panel, from the PCU, or from the remote unit.
RLB + BERT	Currently Performed Test	OFF ON	A remote digital loopback with internal BER tester.
BERT	Currently Performed Test	OFF ON	Built-in pattern generator and tests, activated from the front panel, from the PCU, or from the remote unit. Performs BER test over the link.
LED TEST	Currently Performed Test	OFF ON	LEDs test, activated from the front panel or the PCU.

Local Test - Local Analog Loopback (LLB)

The LLB test checks the performance of the local FOMi-E1/T1 modem, the local data terminal, and the connections between them (see *Figure 4-2*). It is performed separately at the local and the remote site.

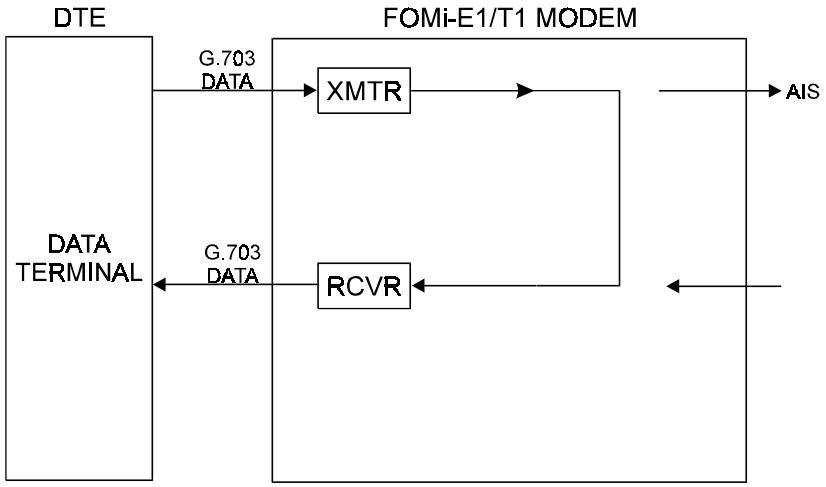

Figure 4-2 Local FOMi-E1/T1 in Analog Loopback (LLB)

➤ **To perform a Local Analog Loopback test:**

1. Press the **CURSOR** button to move to the **Menu Type** field.
2. Press the **SCROLL** button until Tests is displayed.
3. Press the **CURSOR** button to move to the LOC/REM field.
4. Press the **SCROLL** button to select the local modem or the remote modem.
5. Press the **CURSOR** button to move to the **Menu Options** field.
6. Press the **SCROLL** button until LLB is displayed.
7. Press the **CURSOR** button to move to the **Parameters** field.
8. Use the **SCROLL** button to toggle to ON.
9. To start the LLB test, press the **ENTER** button.
   The message WAIT... is displayed on the local modem LCD, and then an asterisk appears next to the ON indication.

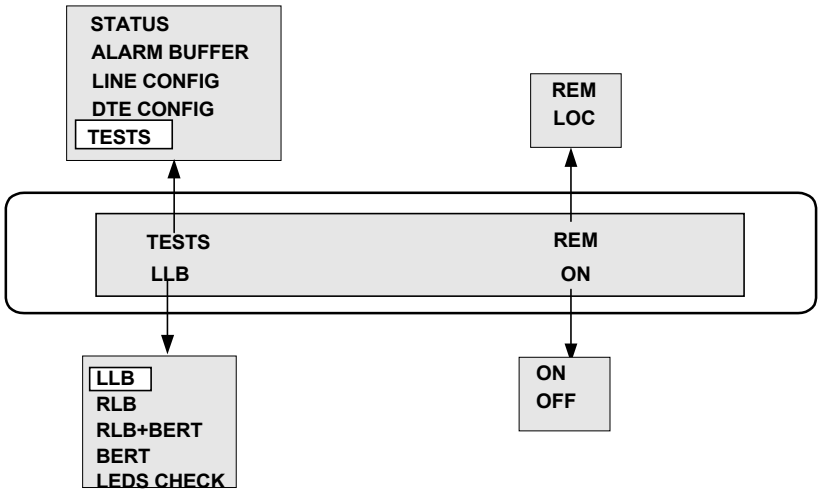

Figure 4-3 FOMi-E1/T1 Tests Menu - LLB

The **TEST** indicator lights up. FOMi-E1/T1 digital interface is now connected to its own DTE data output via most of the modem circuits.

10. Perform this procedure at both ends.
11. If the BERT indicates the correct position, but the data terminal indicates a fault, follow the manufacturer's procedures to test the data terminal and verify that the cable is properly connected between the terminal and the FOMi-E1/T1 unit.
12. After completion of the test (or when the fault has been corrected), deactivate the LLB test.
13. To stop the test, press the **SCROLL** button until OFF is displayed and then press the **ENTER** button.
    The message WAIT... is displayed on the local modem LCD and the test is terminated.

Remote Digital Loopback (RLB)

The Remote Digital Loopback (RLB) test determines the performance of both the local and the remote FOMi-E1/T1 units, as well as their connecting lines. The Remote Digital Loopback test provides a loopback at the remote modem.

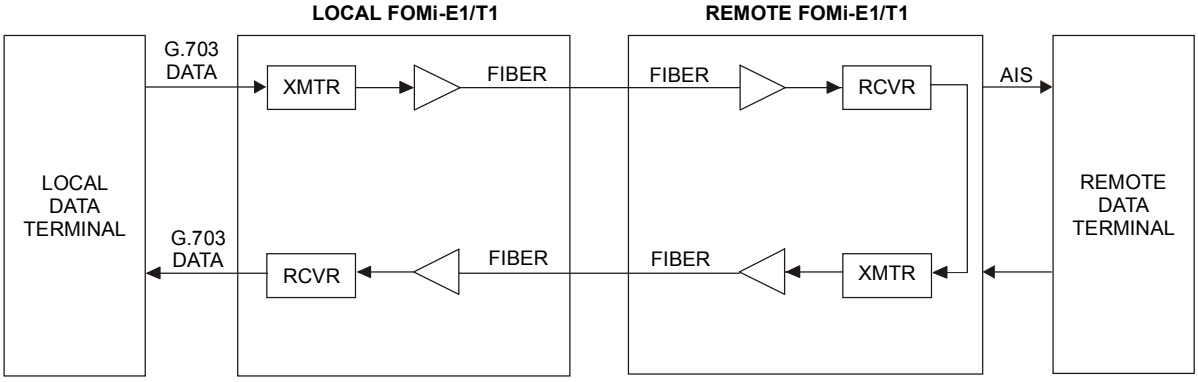

Figure 4-4 FOMi-E1/T1 in Remote Digital Loopback (RLB)

➤ **To perform a Remote Loopback test:**

1. Press the **CURSOR** button to move to the **Menu Type** field.
2. Press the **SCROLL** button until Tests is displayed.
3. Press the **CURSOR** button to move to the LOC/REM field.
4. Press the **SCROLL** button to select the local modem or the remote modem.
5. Press the **CURSOR** button to move to the **Menu Options** field.
6. Press the **SCROLL** button until RLB is displayed.
7. Press the **CURSOR** button to move to the **Parameters** field.
8. Use the **SCROLL** button to toggle to ON.
9. To start the RLB test, press the **ENTER** button.
   The message WAIT... is displayed on the local modem LCD, and then an asterisk appears next to the ON indication.

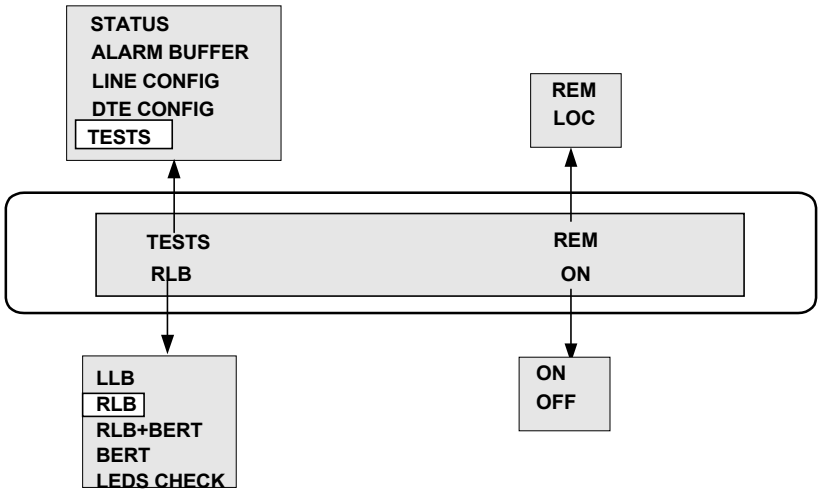

Figure 4-5 FOMi-E1/T1 Tests Menu - RLB

The **TEST** indicator lights up at both the local and remote units. FOMi-E1/T1 digital interface is now connected to its own DTE data output via most of the modem circuits.

10. After completion of the test (or when the fault has been corrected), deactivate the LLB test.
11. To stop the test, press the **SCROLL** button until OFF is displayed and then press the **ENTER** button.
    The message WAIT... is displayed on the local modem LCD and the test is terminated.

Activation by a Remote User

Both LLB and RLB loopbacks can be operated from the local modem and performed on the local and on the remote modems (see *Figures 4-6 and 4-7*). This option is especially useful when there is an authorized technician at the local site and an unskilled user on the other side.

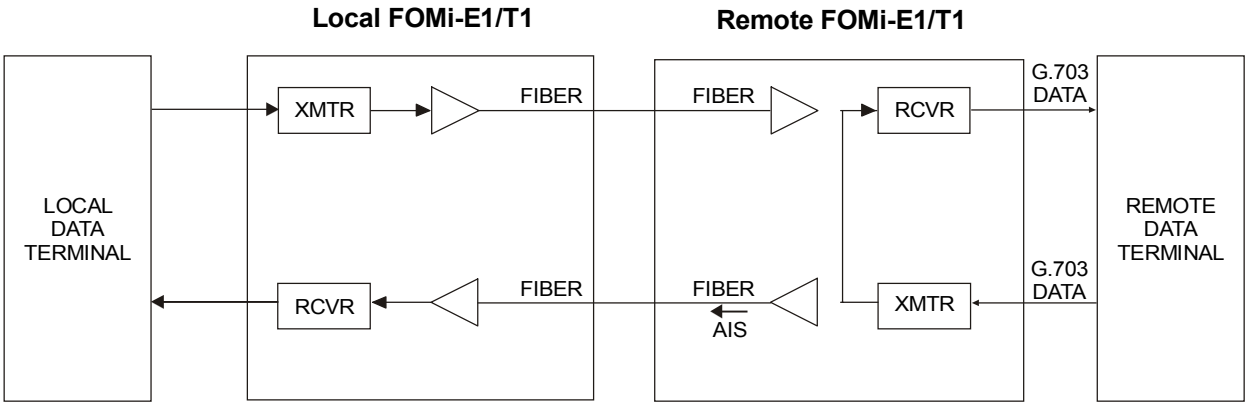

Figure 4-6 Activation of LLB at the Remote Modem

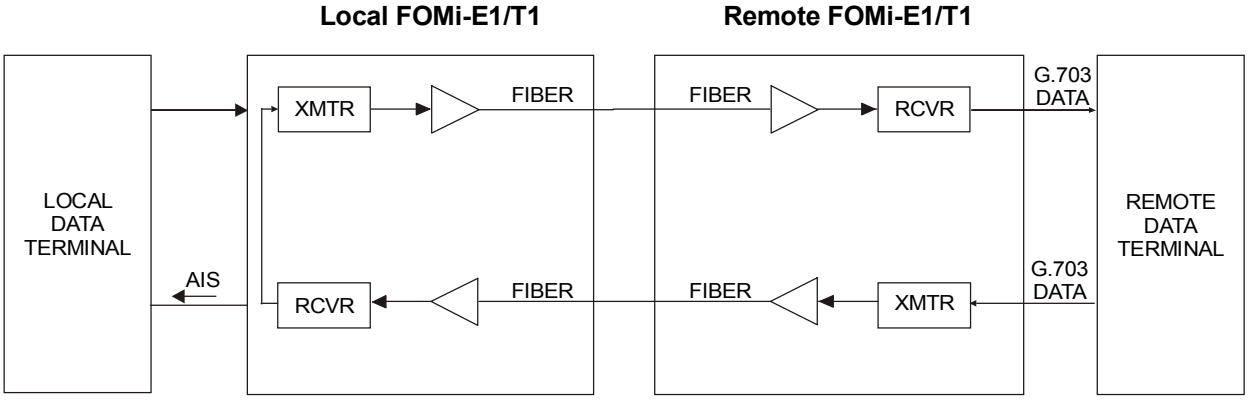

Figure 4-7 Activation of RLB at the Remote Modem

➤ **To run a loopback test from a remote modem:**

1. Press the **CURSOR** button to move to the **Menu Type** field.
2. Press the **SCROLL** button until Tests is displayed.
3. Press the **CURSOR** button to move to the LOC/REM field.
4. Press the **SCROLL** button to select the remote modem.
5. Activate the LLB or RLB by following the menu configuration procedure detailed in the instructions above. The TEST indicator lights up.
6. The remote user should verify that the data equipment is working properly by sending a proper data flow.
7. After completion of the test (or when the fault has been corrected), deactivate the loopback test.

8. To stop the test, press the **SCROLL** button until OFF is displayed and then press the **ENTER** button.
   The message WAIT... is displayed on the local modem LCD and the test is terminated.

Internal BER Tester and Pattern Generator Operation

FOMi-E1/T1 has a built-in BER Tester and Pattern Generator which, together with the V.54 diagnostic loops and a remote BER tester, can check normal system operation and isolate faulty equipment in the event of system failure.

The Pattern Generator, which is automatically activated when the BER Tester is activated, sends a 511 pattern according to the ITU V.52 standard. If errors are detected by the BER tester, the **ERR** LED indicator blinks or remains on. *Figure 4-9* describes the data flow for the operation of the internal BER tester and the Pattern Generator.

The BERT test can be activated simultaneously on both the local modem and the remote modem, thus checking the integrity of the link from both sides of the application at the same time.

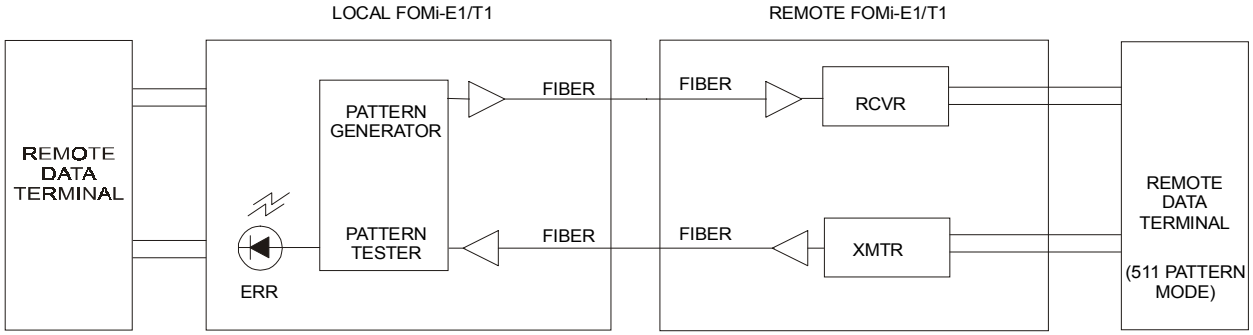

Figure 4-8 FOMi-E1/T1 Internal BER Test

Note *In FOMi-E1/T1 mode of operation, the internal BERT can be performed with an external BER tester. In such a case, the zero suppressing function of the tester must be disabled (AMI code).*

The BERT test is initiated by the user at the local modem. For this test, the modem's internal 511 pattern generator generates a message. The message is sent to the remote modem, and from the remote modem is returned by the remote DTE. When this test is performed, the remote DTE has to be in a 511 mode of operation. The local DTE is disconnected when this test is running.

The BERT is the only test that can be executed from both sides of the line simultaneously. Both modems can initialize their own tests and each LCD will display the BER in the **Menu Options** field.

➤ **To activate a BER test:**

1. Press the **CURSOR** button to move to the **Menu Type** field.
2. Press the **SCROLL** button until Tests is displayed.

3. Press the **CURSOR** button to move to the LOC/REM field.
4. Press the **SCROLL** button to select the local modem or the remote modem.
5. Press the **CURSOR** button to move to the **Menu Options** field.
6. Press the **SCROLL** button until BERT is displayed.
7. Press the **CURSOR** button to move to the **Parameters** field.
8. Use the **SCROLL** button to toggle to ON.
9. To start the LLB test, press the **ENTER** button.
   The message WAIT... is displayed on the local modem LCD, and then an asterisk appears next to the ON indication.
10. To start the BERT test, when the parameters field is set to ON press **ENTER**.
    The message WAIT... is displayed on the local modem LCD and then an asterisk appears next to the ON indication. The ERR LED will blink whenever an error is detected and the BER will be displayed on the LCD of both modems.
11. After completion of the test (or when the fault has been corrected), deactivate the loopback test.
12. To stop the test, press the **SCROLL** button until OFF is displayed and then press the **ENTER** button.
    The message WAIT... is displayed on the local modem LCD and the test is terminated.

Remote Digital Loopback + BERT

The Remote Digital Loopback + BER Test (RLB +BERT) determines the performance of both the local and the remote FOMi-E1/T1 units, as well as their connecting lines. Using an external BER tester, it measures bit error rate through the link.

Figure 4-9 describes the data flow for the operation of the external BER tester.

➤ **To activate a BER test:**

1. Press the **CURSOR** button to move to the **Menu Type** field.
2. Press the **SCROLL** button until Tests is displayed.
3. Press the **CURSOR** button to move to the LOC/REM field.
4. Press the **SCROLL** button to select the local modem or the remote modem.
5. Press the **CURSOR** button to move to the **Menu Options** field.
6. Press the **SCROLL** button until RLB + BERT is displayed.
7. Press the **CURSOR** button to move to the **Parameters** field.
8. Use the **SCROLL** button to toggle to ON.

9. To start the LLB test, press the **ENTER** button.
   The message WAIT... is displayed on the local modem LCD, and then an asterisk appears next to the ON indication.
10. To start the RLB + BERT test, when the parameters field is set to ON press **ENTER**.
    The message WAIT... is displayed on the local modem LCD and then an asterisk appears next to the ON indication. The ERR LED will blink whenever an error is detected and the BER will be displayed on the LCD of both modems.
11. After completion of the test (or when the fault has been corrected), deactivate the loopback test.
12. To stop the test, press the **SCROLL** button until OFF is displayed and then press the **ENTER** button.
    The message WAIT... is displayed on the local modem LCD and the test is terminated.

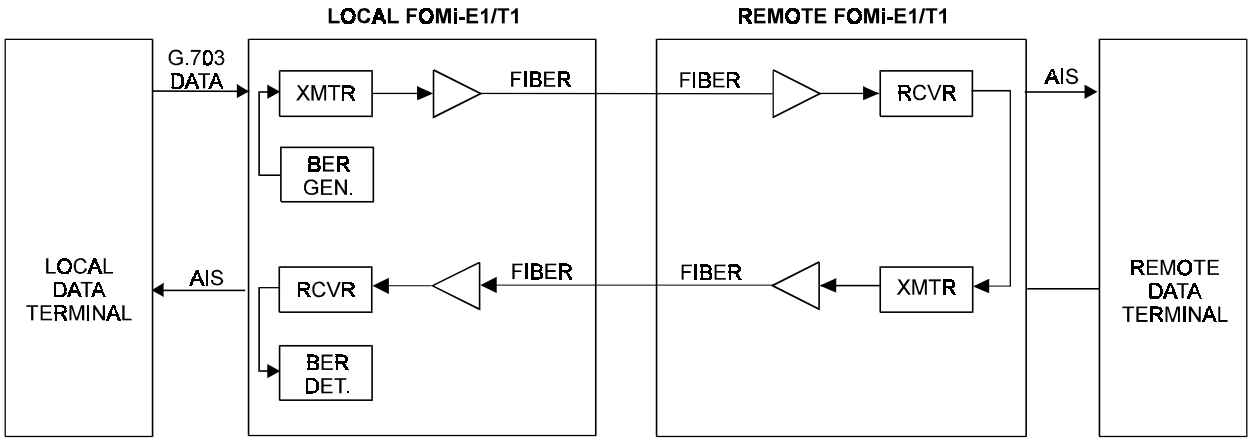

Figure 4-9 FOMi-E1/T1 in Remote Digital Loopback + BERT (RLB+BERT)

LEDS Check

The LEDS CHECK enables you to check that the LED indicators on the front panel of the modem are operating.

➤ **To run a LEDS CHECK:**

1. Press the **CURSOR** button to move to the **Menu Type** field.
2. Press the **SCROLL** button until Tests is displayed.
3. Press the **CURSOR** button to move to the LOC/REM field.
4. Press the **SCROLL** button to select the local modem or the remote modem.
5. Press the **CURSOR** button to move to the **Menu Options** field.
6. Press the **SCROLL** button until LEDS CHECK is displayed.
7. Press the **CURSOR** button to move to the **Parameters** field.

8. Use the **SCROLL** button to toggle to ON.
9. To start the LEDS CHECK, press the **ENTER** button.
   The message WAIT... is displayed on the local modem LCD, and then an asterisk appears next to the ON indication.

All the LEDs on the front panel should light. If management is inactive, the LOC CONFIG ONLY message will appear on the LCD.

10. A few seconds after completion of the check the LEDs will turn off.
11. To stop the test, press the **SCROLL** button until OFF is displayed and then press the **ENTER** button.
    The message WAIT... is displayed on the local modem LCD and the test is terminated.

Appendix A
Rack Installation

A.1 Installation of the Unit Case into a 19" Rack

General

The height of the unit is 1U (1.75"); the width of the unit is slightly less than half the available mounting width. A rack adapter kit, RM-9, is available for installing either a single unit or two units side by side in the 19" rack.

Warning

Disconnect AC power before opening the unit.

Installation of a Single Unit

Rack adapter components for installing a single unit include one short bracket and one long bracket. Each bracket is fastened to the side walls of the unit by two screws which are inserted into the two front holes on the side wall. (The unit is supplied with nuts already in place on the inner side wall). Note that the short bracket fastens to the left side of the unit, and the long bracket to the right side of the unit (see *Figure A-1*).

Once the brackets are fastened to the side walls, the unit is ready for installation in the 19" rack. Place the unit in the rack and fasten the brackets to the side rails of the rack using two screws on each side (not included in the kit).

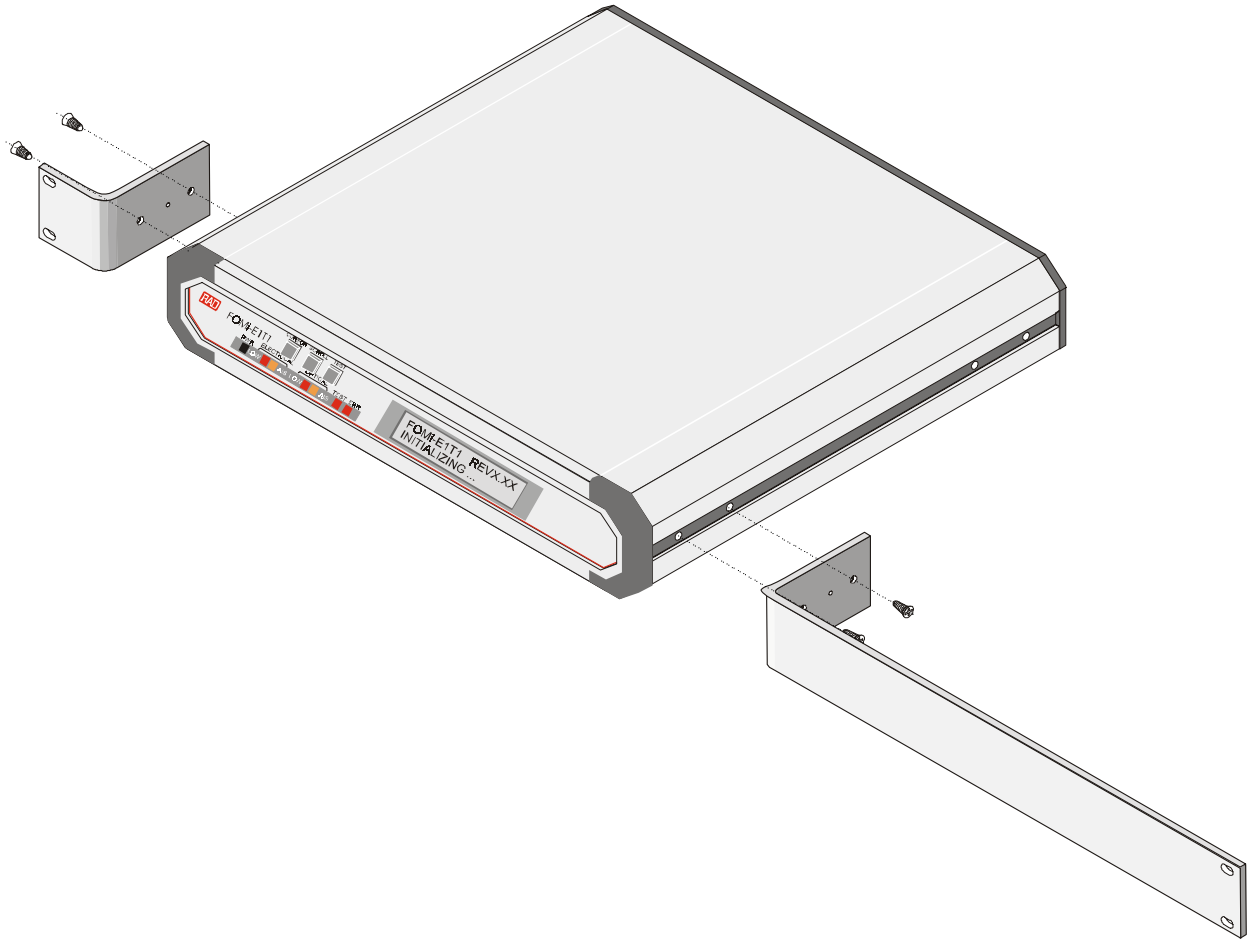

Figure A-1 Installation of a Single Unit

Installation of Two Units

Rack adapter components for installing two units include two long side rails (one for each unit) which slide one into the other fastening the two units together, and two short side brackets which hold the two units in the 19" rack (see *Figure A-2*).

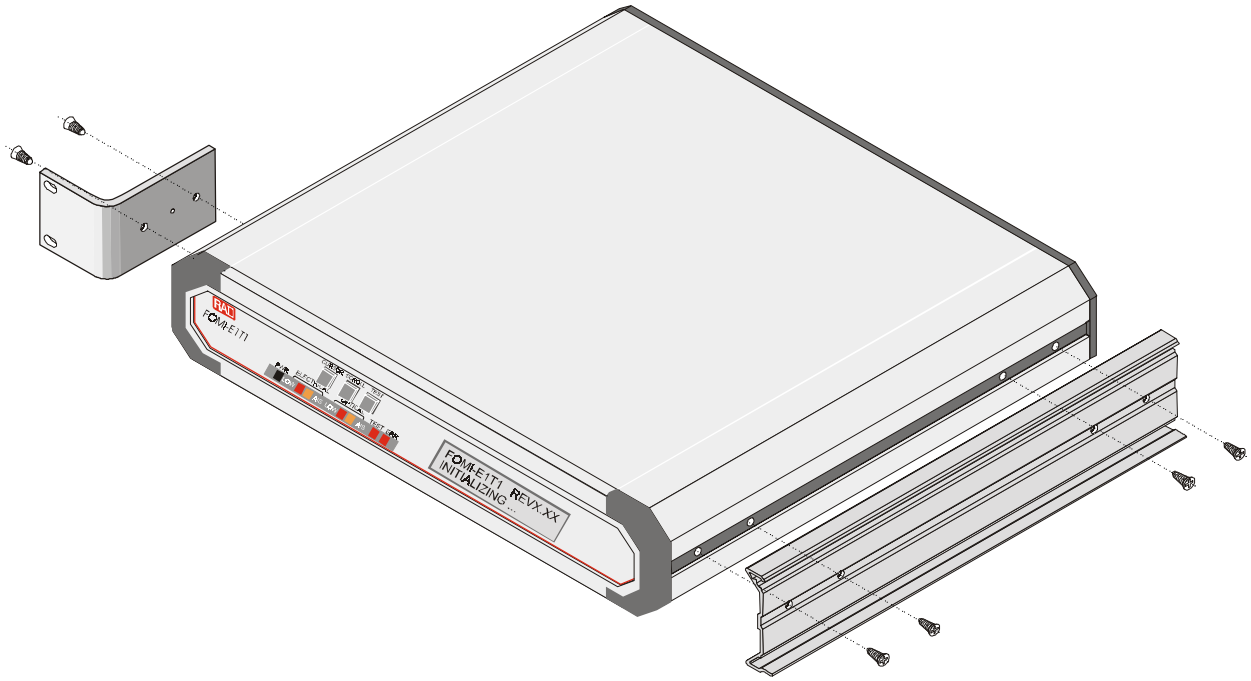

Figure A-2 Installation of Two Units

To install two units:

1. Fasten one long side rail to each unit (right side to one unit, left side to the other unit) using the four screws supplied. The side rails must be attached in opposing fashion, the narrow flange of the first rail opposite the wide flange of the second rail.
2. Attach one short bracket opposite the side rail on each unit using the 4 screws supplied.
3. Slide the side rail of one unit into the side rail of the other unit, joining the two units together (*see Figure A-3*).
4. Secure the supplied plastic caps to the ends of the rails to prevent the units moving and to protect the rail ends.
5. The assembled units can now be fastened to the side rails of the 19" rack by means of four screws to each side(not included in the kit).

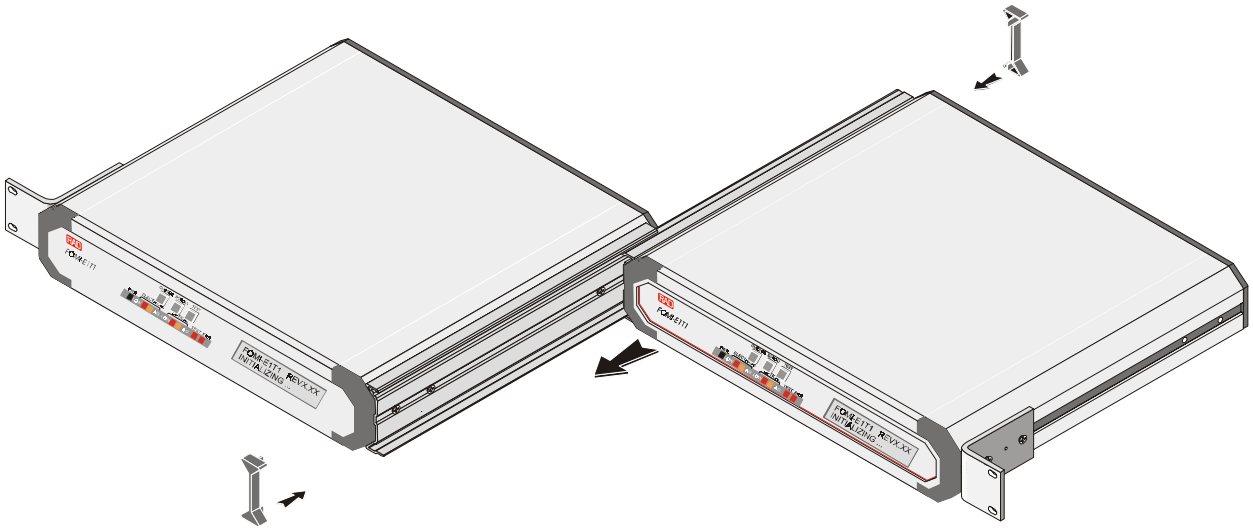

Figure A-3 Fastening Two Units Together